A Synthesis of Research Needs for the Great Bay Estuary

**Results from the
"Research in the Great Bay Estuary:
Developing an Integrated Framework to Advance Our State of Knowledge" Great Bay Workshop**

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Great Bay
National
Estuarine
Research
Reserve

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Introduction

As part of the State of the Estuaries Conference held in October 2003, the Great Bay National Estuarine Research Reserve organized a workshop to develop a list of research needs for the Great Bay Estuary. A diverse group of 77 participants representing state and federal government agencies, non-profit groups, academic institutions, and conservation commissions attended the workshop. After an introductory orientation session, participants formed five break-out groups, ranging from 8 to15 participants each, assigned to one of five resource topic areas: living resources (LVR), altered habitats (HAB), water quality nutrient and microbial contaminants (WQN), water quality toxic contaminants (WQT), and land use planning (LUP). Participants were assigned to a topic area according to their background.

Analysis of the break-out discussion results reveals that the groups independently generated needs representing five common themes:

- **Data management, analysis, and dissemination**
- **Mapping and characterization needs**
- **Indicator development**
- **Stressor/response/impact investigations**
- **Ecosystem level – trophic interactions/community changes**

These categories represent a continuum from basic data needs and presentations that support research, to complex investigations dealing with ecosystem function and community interactions. More than one group addressed issues such as nutrient loading. Therefore, the ideas of multiple groups were often combined to form one statement around common issues. The following document details the specific research needs generated under each theme as well as a general strategy to address them.

Research Needs

Data Management, Analysis, and Dissemination

- Establish the best available baseline and historical data to examine benthic communities
- Review the existing information and analyze trends for species and communities at risk
- Support data mining and integration for toxic contaminant information to document historical loads, seasonal changes, develop forecasting methods, and mass balance budgets on a per contaminant basis.
- Improve utility of existing information for land use planning by examining barriers to its use and developing an adaptable user-friendly clearinghouse to support the planning process, identify data gaps, and indicate future research needs (first determine need for such a product by consulting user groups).
- Integrate and maintain long-term water quality data sets to improve accessibility and utility for multiple user groups.

Mapping and Characterization Needs

- Understand the type, extent, and distribution of altered habitats by mapping locations and associated habitats, characterizing un-impacted habitat, and evaluating restoration feasibility.
- Define the extent and distribution of impervious surface at sufficient spatial scale to support research into its effects on adjacent habitats.
- Map substrates, the associated benthic infauna, and identify essential "mobile" animal habitat.
- Identify and characterize species and communities at risk and better understand stressors responsible.
    - Assess non-point nutrient sources such as septic systems, storm-water events, groundwater discharge, and agricultural contributions as part of an overall nutrient budget.
- Identify local human assisted transport mechanisms for invasive species and investigate appropriate methodologies for prevention and control.
- Identify the most significant sources of known toxic contaminants.
- Build on hydrodynamic models for Great Bay to provide better representation of residence time, transport, and fate of particles by incorporating small tributaries.
    - Identify barriers preventing local decision makers from implementing better land use planning tools, and develop specific measures to address those barriers.
- Identify, map, and quantify spawning habitat then develop indices for comparing the relative importance of these habitats for rainbow smelt (especially need subtidal information), winter flounder, and andromous alosid species in Great Bay tributaries.

Indicator Development/Use

- Use keystone species such as eelgrass and oysters to identify small scale/local water quality problems
- Further development of microbial indicators and source tracking techniques specifically by improving turn around time and reliability of indicators.
- Recognize key system drivers/issues such as alteration of freshwater flow, introduced species, sea-level rise, and dams in the context of altered habitats.
- Develop improved, more sensitive indicators of environmental quality (i.e. – depth at which eelgrass occurs, benthic community structure, macroalgae, waterfowl foraging pattern changes, occurrence of opportunistic epiphytes on eelgrass etc.).
- Investigate climate change level impacts on indicators in context of examining at risk communities.
- Define a suite of indicator species (~10 to 20 potentially stratified by trophic level) that reflect the whole ecosystem condition and establish quantitative methods to monitor their abundance and condition.
- Identify appropriate metrics for evaluating the effect of changing land use on natural resources.

Stressor/Response Investigation

- Define universe of potential effects on the ecosystem due to toxic contaminants (i.e. – examine susceptibility of organisms at different life stages or seasons, investigate differences between acute effects from catastrophic events vs. cumulative effects from persistent sources of contaminants and potential interventions for both.)
- Define synergistic effects between toxic contaminants and other physical, biological, or chemical factors such as turbidity, storm-water, temperature, current velocity, salinity etc. Most of this work has occurred in fresh or salt water, not estuaries.
- Understand the effects of habitat alteration on ecosystem function by examining response variables such as biodiversity, water quality, fisheries, hydrology, geomorphology, effects on adjacent ecosystems etc.
- Understand the effects of management by defining and assessing the strategies used such as land protection and active restoration. (note: strengthens the need for established baselines and long term monitoring).
- Determine the biological fate of nutrients in Great Bay by examining potential sources and sinks, building chemical fate models, and measuring response by organisms such as oysters and eelgrass.
- Investigate the connection between land use change and nutrient loading in the Great Bay watershed.
- Understand and minimize the effects of impervious surfaces in coastal area by researching the impacts at multiple scales within the watershed as well as identifying an effective means to limit its extent. Provide this model to local decision makers.

- Demonstrate and evaluate new approaches to minimize impervious surface and better manage stormwater in a variety of NH sites and conditions (i.e., evaluate the application of low-impact development approaches in NH conditions).
- Evaluate factors that influence the effect of impervious cover on water quality (e.g., examine the role of different types, sizes and locations of buffers, the effect of different stormwater management and age of management facilities, the effect of different types of developed land use activities).
- Investigate relationships between water quality and survival/numerical production of anadromous fish in coastal rivers using current and historical water quality and fisheries data.
- Continue to understand the microorganisms present on lobster shells and implicated in causing chitinulytic shell disease.

Ecosystem Level / Trophic Dynamics

- Understand benthic habitat change and interaction between living and non-living constituents of the intertidal zone through quantification of estuarine food webs and synthesis of estuarine processes for ecosystem management.
- Increase understanding of the stressors responsible for species and communities at risk due to invasive species, climate change, etc.
- Develop a better understanding of the population dynamics associated with lesser-studied species (i.e. – horsehoe crab, salt marsh sparrows)
- Understand ecosystem response to increased nitrogen in the estuary by examining effects on multiple communities and levels (i.e. – phytoplankton, eelgrass, macroalgae fish, zooplankton, birds, benthic invertebrates etc.)
- Understand the transport pathway by which each toxic contaminant enters and exists the system.
- Identify the processes that affect the bio-availability of toxic contaminants in the system.
- Identify potential cascading effects within the ecosystem due to the loss or impairment of individual species.
- Examine the cumulative impact of local land use planning decisions on the Great Bay watershed.
- Build on the current level of understanding of the oyster reproductive cycle in the Great Bay (i.e.- gondal development, spawning, larval development, and setting/post-settlement survival) to identify potential bottlenecks and aid future restoration projects.

Implementation

The above list of research needs will be addressed by NERRS programs and through collaboration with other interested parties. Limited research funds presently flow to the reserve to support a request for proposals addressing these specific needs. In addition, opportunities such as the NERRS Graduate Research Fellowship program (GRF) can be used to this end. Students interested in applying for graduate research fellowships are encouraged to contact the research coordinators at the reserves where they plan to do research. The research needs outlined above will be provided to all students expressing interest in the fellowship.

Fostering partnerships and communicating funding opportunities to appropriate investigators will result in projects that address needs outlined in this document as well. Continuing partnerships and developing new ones with faculty and staff at local and regional universities, government agencies, and non-profits will also be essential in addressing the research needs. Relationships with partners such as the New Hampshire Estuaries Project, The Nature Conservancy, NH Department of Environmental Services, NH Coastal Program, US Fish and Wildlife Service, and the University of New Hampshire have resulted in projects that are already addressing some of the issues outlined above. Continued efforts with these and new partners will generate additional projects aimed at addressing the research needs discussed above.